



BIODIVERSITY INITIATIVE SITE PLAN
Sandplain Grassland & Pitch Pine/Scrub Oak Savannah Restoration
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Frances Crane Wildlife Management Area North
Falmouth, Massachusetts

Introduction

The Massachusetts Division of Fisheries and Wildlife (DFW) Biodiversity Initiative plans to maintain and restore fire-adapted sandplain grassland with some pitch pine/scrub oak savannah habitat on about 200 acres of the Frances Crane Wildlife Management Area (WMA) north of Rte. 151 in Falmouth, MA. Sandplain grasslands have become extremely rare in Massachusetts and are ranked as a critically imperiled natural community (<http://www.mass.gov/eea/docs/dfg/nhesp/natural-communities-facts/priority-natural-commun.pdf>). The 2013 state-wide action plan for state listed grassland birds (<http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/grassland-bird-plan-final.pdf>) ranked this portion of the Frances Crane WMA as a top priority site with the highest restoration potential.

This site occurs on dry, sandy, glacial outwash soils. Prior to acquisition by DFW, this area was used for agriculture (including pastureland and the growing of strawberries, asparagus, corn, and tomatoes), and a grass airstrip supported small private aircraft into the 1950's. The Division purchased most of the acreage both north and south of Rt. 151 in 1958 from the Coonamessett Ranch Company. North of Rt. 151, early-successional pitch pine and oak shrubland/forest became established between 1960 and 1980. The Division conducted periodic mowing of the abandoned airstrip and some abandoned fields adjacent to the airstrip. Beginning in the 1990's the Division used prescribe fire on portions of the abandoned airstrip and surrounding grasslands for rare species habitat management and for public safety.

The desired future condition for this site is a fire-adapted sandplain grassland community adjacent to open pitch pine/scrub oak savannah that will support plant species such as the Federally Endangered Sandplain Gerardia (*Agalinis acuta*), and animal species such as the Endangered Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (Threatened) (*Ammodramus savannarum*) and Chain-Dot Geometer (Special Concern) (*Cingilia catenaria*).

Background

DFW landscape goals for wildlife habitat (Fig. 1) have received broad public support and call for 20-25% of uplands in open habitats (including grassland, shrubland, and young forest) and 75-80% in a full-canopy forest condition, including 10-15% in forest reserves across approximately 2000,000 acres of state WMA's. These goals are science-based and respond to the state-wide and regional decline in young forest, shrubland, and grassland habitat and associated wildlife caused by direct losses from development and alteration of natural disturbance processes (e.g. flooding, fires, etc.).

The DFW Biodiversity Initiative was established in 1996 to maintain and restore native diversity of flora and fauna through active land management, and has brought together Restoration Ecologists from the DFW Natural Heritage & Endangered Species Program (NHESP) and University of Massachusetts professors and students along with Wildlife Biologists and Foresters from the DFW Habitat Program to conduct this extensive restoration effort. This effort will help address the decline of wildlife species of greatest conservation need associated with open habitats identified in the Massachusetts Wildlife Action Plan (http://www.mass.gov/dfwele/dfw/habitat/cwcs/cwcs_home.htm). The Wildlife Action Plan is a comprehensive strategy for identifying the state's key species requiring conservation actions and the habitats they occupy.

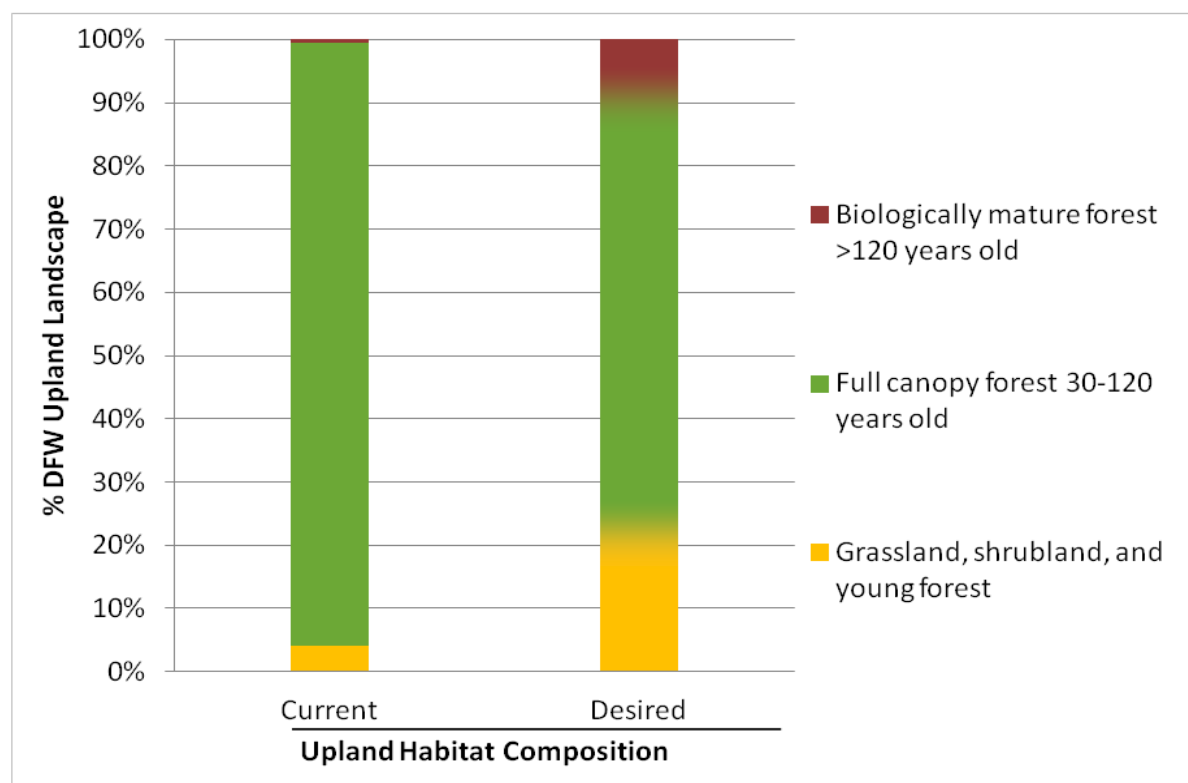


Fig. 1. Current and desired upland habitat composition of over 123,800 acres of upland on 152,666 acres owned by Massachusetts Department of Fish and Game as of 2012.

Open habitats such as grasslands, shrublands, and young forest have been a part of the New England landscape for millennia. Prior to European colonization, natural disturbance processes including beaver activity along thousands of streams throughout Massachusetts, and recurrent spring flooding along dozens of river courses generated extensive patches of open habitats across the state. Beaver dams form extensive shallow ponds that typically persist for years or decades until the beaver exhaust local food supplies and abandon the flowage. The abandoned dam soon falls into disrepair and ultimately breaches, allowing the extensive flowage to drain, leaving in its wake an open fertile site that is quickly colonized by herbs and shrubs that provide extremely beneficial wildlife habitat. Likewise, spring flooding following ice-out along major rivers resulted in flowing ice scouring extensive areas along the river banks that were typically colonized by herb and shrub vegetation after floodwaters subsided.

In addition, both wildfire and fires set by Native Americans along the coast and rivers (Patterson & Sassaman 1988) and in the uplands adjacent to major river valleys (Byers 1946) contributed additional, extensive open habitats. Windstorms also create patches of open habitat, but most wind events in northeastern forests typically result in small (<0.1 ha) openings (Runkle 1982, Lorimer and White 2003). Hurricanes and tornadoes (like those that devastated portions of several Massachusetts towns in June of 2011) do occur in southern New England, but relatively infrequently. While occasional major windstorms can create extensive patches of open habitat that can periodically bolster local populations of wildlife species that benefit from disturbance, the infrequent occurrence of major wind events typically cannot sustain populations of disturbance-dependent wildlife species over time. Rather, these species historically relied on more routine disturbance events like flooding and fire.

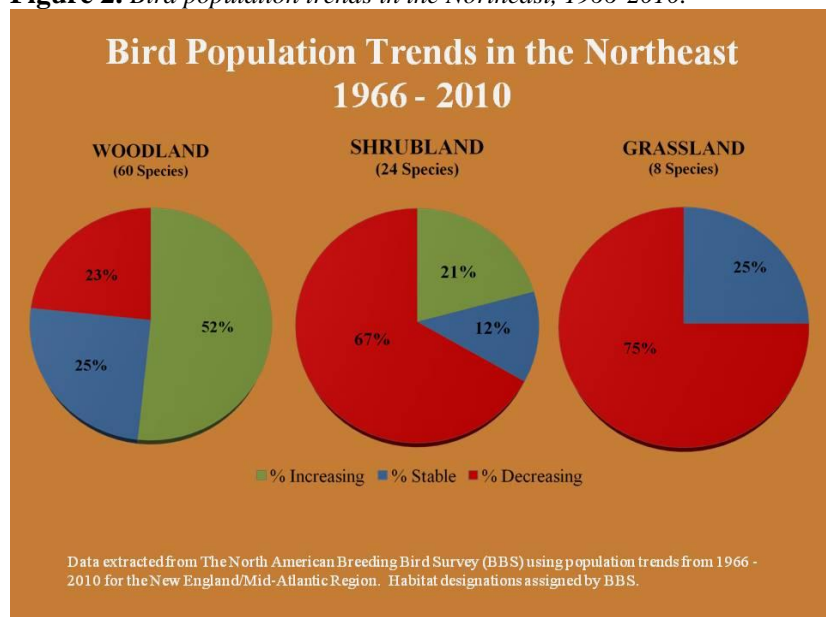
However, during the 18th century, beaver were extirpated from Massachusetts by unregulated trapping (Foster et al., 2002), then in the 19th century humans began constructing dams along streams and rivers, eliminating many open habitats that had formerly been provided by spring flooding events along major watercourses. During this same time period Native American tribes were decimated by European diseases like small pox and by conflict with European settlers, and fire became far less common in coastal areas and major river corridors. But in what can be seen as a great

ecological irony, many native wildlife species associated with these natural disturbance habitats actually increased despite the extirpation of beaver, the damming of streams and rivers, and the substantial reduction in fire because much of Massachusetts' original forests were cleared for farming and fuelwood, creating a landscape dominated by open habitats where extensive old-growth forest had formerly occurred. These dynamic landscape changes created conditions where wildlife species associated with open habitats such as bobolinks and northern harriers thrived (Cronon 1983, Foster & Aber 2004, Whitney 1994).

As Massachusetts agricultural lands were abandoned from the 1850's into the early 1900's, and as the use of fuelwood gave way to fossil fuels in the mid-1800's, fallow fields and abandoned woodlots became very productive wildlife habitat for species such as American woodcock, whip-poor-will, prairie warbler, eastern towhee, field sparrow and New England cottontail. Eventually though, beginning around the 1960's, abandoned fields and woodlots succeeded to closed-canopy forest, and wildlife species dependant on grasslands, shrublands, and young forest habitats declined dramatically (Hill and Hagan 1991, Litvaitis 1993). This decline, along with limited forest regeneration cutting, and suppression of natural disturbance processes (i.e. flooding and fire) have resulted in a relative scarcity of these habitats in Massachusetts today (USDA 2000). The on-going decline of open habitats in New England is recognized as a serious threat to biodiversity; many wildlife species dependent on these habitat types are in decline (Askins 1998, DeGraaf & Yamasaki 2001, Litvaitis 2003). Native bird population trends show alarming declines for both grassland and shrubland birds, as well as for some forest nesting birds that move from mature forest after nesting to utilize food and cover resources found in open areas (Fig. 2). Consequently, all of the New England states include grassland, shrubland and young forest habitats and many associated wildlife species in their states' Wildlife Action Plans as species of conservation need (http://www.teaming.com/state_wildlife_strategies.htm).

Beaver returned to Massachusetts in the early 1900's and with the introduction of trapping regulations their population increased in size. This provided some high quality wildlife habitats, but human land use (primarily urban and suburban development, and road construction) eliminated many sections of low gradient streams from beaver activity (beaver are routinely removed from sections of stream wherever roads cross streams through culverts or under bridges, and beaver are also routinely removed when their flooding activities pose a threat to well fields, septic fields, or other development infrastructure). In short, after beaver were extirpated from Massachusetts, human population increased rapidly, and the same types of places preferred by beaver (relatively flat areas with good access to fresh, flowing water) are also preferred for human development. So, while beaver are once again part of our landscape today, their ability to establish extensive patches of open habitat has been substantially constrained by human development.

Figure 2. Bird population trends in the Northeast, 1966-2010.



Treatment Area Condition: Prior to the management actions described below, areas north of Route 151 contained abandoned farmland and an abandoned airstrip. The abandoned airstrip contained a mixture of native warm season grasses and exotic cold season grasses, with sporadic infestations of invasive exotic plants. Conifer hedgerows (primarily composed of red pine) had been planted within the airstrip following abandonment. Abandoned farmlands near the old airstrip contained a mixture of grasses, forbs, and encroaching trees, primarily red cedar, black locust, red pine and pitch pine. Adjacent second-growth forest areas included Pitch pine (*Pinus rigida*) and oaks (*Quercus* spp.). The understory in these areas includes scrub oak, huckleberry (*Gaylussacia baccata*) and blueberries (*Vaccinium* spp.).

Soils: Carver loamy course sand, Carver coarse sand, East chop loamy fine sand, Enfield silt loam, and Merrimac Sandy loam.

Habitat Management Goal: For areas north of Route 151, DFW wants to: 1) increase the amount (patch size) and the quality of the warm season grasslands to support declining native wildlife and plant species; 2) enhance scrub oak shrubland habitat; and 3) establish patches of young forest habitat within full canopy forest outside grassland and shrubland areas. Collectively, these actions will provide habitat for both state-listed species and traditional game species such as American woodcock, ruffed grouse, and cottontail rabbits. Some grassland bird species which are experiencing alarming declines (Upland Sandpiper, Grasshopper Sparrow) require large patches of grassland habitat with unobstructed sightlines (O'Leary and Nyberg, 2000). Hedgerows were removed from the grassland as well as converting second growth forest back into shrubland and grassland to increase the overall area of early-successional habitat. Since the vegetation on Cape Cod has evolved with regular fire events, prescribe fire is used on portions of the grasslands every year conditions permit. This habitat is fire-dependent, and fire suppression activities over the last century have degraded habitat for associated native species.

In recent decades, many bird species found in early successional habitat have shown alarming declines in New England (Sauer et al, 2004). Research has shown that these declines are primarily a result of habitat loss (Schlossberg and King, 2007). Large open habitat patches occurred naturally prior to European colonization from beaver activity in low gradient sites (which are now largely developed for human use), and from frequent ice-scouring along major stream and river courses during spring flood events (dam construction has largely curtailed this type of natural disturbance) (Chandler et al, 2009, Jones and Vickery, 1997). Wind and fire also contributed to the creation of open patches of shrubby habitat but are also now altered (wind by human development) or controlled (fire by suppression). Ironically, the human restriction of natural disturbance processes does not appear to have adversely impacted terrestrial wildlife species associated with extensive patches of early successional habitats during the 1800's and early 1900's due to the abundance of active, then abandoned agricultural lands throughout the state. However, now that forest has fully reclaimed most remaining abandoned agricultural lands, human restrictions on natural disturbance processes are keenly felt by the terrestrial wildlife species associated with extensive patches of early successional habitats.

In order to maintain the native biodiversity originally found in Massachusetts early successional habitats', active management today needs to replace the natural events that created large open habitat patches in the past (Litvaitis, 1993, King et al, 2009). In order to provide the highest quality habitat for Massachusetts early successional birds, habitat patches should be at a minimum two acres with larger patch sizes providing better habitat for a larger number of species (Degraff and Yamasaki, 2003, Schlossberg and King, 2007). Management should also take into account the range of preferred vegetation characteristics that the different species of birds use for food, nesting, and cover; habitat patches should have a range of low vegetation consisting of grasses and forbs as well as areas of taller vegetation consisting of abundant shrub cover (Schlossberg et al, 2010).

Grassland birds in North America and particularly in the Northeast have been showing steep and dramatic declines due to both a loss of contiguous habitat and the continuing decline in the quality of habitat (Askins 1993, Knopf, 1994, Noss et al., 1995). The Breeding Bird Survey results from 1966 to 1994 also point to alarming declines for many grassland bird species in the Northeast. Part of the difficulty in maintaining grassland bird species is that many of them are area sensitive, requiring minimum areas of >15 acres (Vickery et al., 1994). Creating larger grassland habitat patches and concentrating them in one portion of a landscape provides resources not only for edge and non-area dependent species (e.g., ruffed grouse, gray catbirds, bobolinks, and eastern meadowlarks), but also the more area dependent species which also tend to be more rare (e.g., grasshopper sparrows, northern harrier, Henslow's sparrow) (Herkert 1994, Herkert et al.

1993, Reese and Ratti 1988). It also helps minimize the deleterious impacts associated with edge and fragmented habitats such as predation on ground-nesting birds and reptiles by edge-associated predators (Andr n and Anglestam 1988).

The 150+ acres of contiguous sandplain grassland occurring at Frances Crane WMA is one of the best remnants of this habitat in Massachusetts. It is also a site that is showing a quick and well-documented response to the introduction of an active restoration management regime. Historically a site that held vigorous populations of sandplain grassland specialists, the site was seriously waning as a relevant community by the late 1990's due to fire suppression, communal succession and invasive *plant* colonization. Then, in 2000 a management plan was set into motion that revolved around the introduction of prescribed fire with the intention of restoring this sandplain to its historic condition and allowing its specialist species to recover. The following years have shown a dramatic enhancement in the community's integrity, perhaps best illustrated by the recovering population of Grasshopper Sparrow. Reduced to just three pairs at the site in 2001, GRSP numbers have not only been steadily increasing since, but their territories have been shown to be expanding through the site in direct correlation to prescribed fire units. 2005 saw a historic high of nine breeding pairs on the site with territories almost exclusively occurring in habitat recently reclaimed by fire. In the near future about twice the acreage of reclaimed grassland will come on-line as GRSP habitat, setting the stage for a further leap in GRSP numbers at the site.

Management within the sandplain grassland has also been correlated to the vigor and expansion of the Federally Endangered Sandplain Gerardia (*Agalinis acuta*), which has shown a trait of colonizing fire units similar to that of GRSP. And since management began, new occurrences on the site of state-listed species such as Upland Sandpiper, Vesper Sparrow and Chain-Dot Geometer (*Cingilia catenaria*) have been documented.

Habitat Management Objectives:

- (1) Create/maintain extensive patches of contiguous shrubland habitat and high quality grassland habitat through reclaiming abandoned agricultural fields (pasturelands), and limited conversion of adjacent second growth forest units to maintained shrublands, grasslands, and savanna.
- (2) Increase structural diversity through mowing/burning scrub oak and other native shrubs (e.g., blueberry and huckleberry spp.) as well as young forest creation to provide habitat for game and non game species
- (3) Maintain a high percent cover of native flora by treating invasive exotic plant species.
- (4) Protect public safety by decreasing the likelihood of a severe fire event .

Management Actions, (tree removal, mowing, invasive plant control, and prescribed fire) 1998-2014

During the summer of 1998, approximately 53 acres were cleared of invading woody vegetation using three Brontosaurus mulchers. An additional 25.5 acres were cleared using whole tree shears along the periphery of the site and 13 acres of trees were also sheared within the initial clearing that were too large to handle with the Brontosaurus. In January, 1999 another 15 acres were cleared using a tree shear and hydroaxe type flail mowers. This area had been previously open 20+ years ago, but had reverted to red cedar, scrub oak, pitch pine, and white oak, with many stems over 6" in diameter. In 2001, 31 acres were mowed which were originally tree sheared in 1998. In 2004, 23 acres had stumps that were remaining from the 1998 tree clearing operation, ground at least 2" below the surface in order to facilitate grassland establishment.

In 2007, 22 acres of 20+ year old abandoned pasture in the southern portions of the grasslands were tree sheared and mowed. In 2009, seven acres of hedgerows consisting of Norway spruce, black locust, and cedar were removed to increase the continuous sightline of the grasslands. Prescribed fire units were burned as conditions permit on a rotational basis starting in 2000. Woody invasives, including multiflora rose, black locust, bittersweet, honeysuckle species, autumn olive, and herbaceous invasives like Spotted Knapweed (*Centaurea biebersteinii*), were selectively treated by a licensed vendor with a foliar application of MA DEP sensitive area herbicide. Treatments were conducted in different portions of fields, hedgerows and reclaimed areas in 1999 (44 acres), 2000 (9 acres), 2001 (20 acres), 2002 (17 acres), 2003 (34.8 acres), 2004 (24 acres), 2006 (7 acres), 2007 (33 acres), and 2009 (87 acres) (Fig. 3). At least 95% control of targeted plants was required for each application, and care was exercised to insure that non-target organisms are not affected by invasive plant control procedures. A variety of rare species occur on the Crane WMA and MassWildlife worked with the Vendor to insure that herbicide applications did not negatively impact rare plants, animals, or their host plants.

In 2014, grassland expansion is expected to begin in unit 1 (Fig. 3). Approximately 32 acres of second-growth forest in unit 1 will be cleared of trees, have understory shrubs mowed, have tree stumps ground to a depth of $\geq 4''$, then be disced (harrowed) and planted to native warm season grasses such as Little bluestem (*Schizachyrium scoparium*).

Francis Crane North

+Brush Mow/Mulch Dates: Winter 1998/1999, 2001/2001, 2004/2005, 2013/2014	+Tree removal Dates: Winter 1999/2000, Winter 2007/2008, Winter 2008/2009, Winter/Spring 2014
+Prescribed Fire: Annually as conditions permitted	+Invasive Exotic Plant Control: Summer 1999, 2001-2013

Potential Future Management Actions, (tree removal, mowing, invasive plant control, and prescribed fire) at Francis Crane North

Future management will include expansion of the grassland unit to areas east, north and west of the current grassland (Fig. 3) as well as the continued treatment of invasive plants across all treatment units. Additionally, prescribed fire will be continued or reintroduced to recently reclaimed grassland expansion units as well as to the surrounding pitch pine scrub oak areas and to oak savanna areas. Treatment prescriptions for the grassland expansion units will include tree removal, mowing, stumping, grading, herbicide treatment, and native warm season grass seeding. Pitch pine scrub oak units as well as oak savanna units will utilize limited overstory removal, mowing or prescribed fire, and potentially invasive plant control. DFW will also focus on enhancement of scrub oak shrubland habitat and establishment of patches of young forest habitat within full canopy forest outside grassland areas. Collectively, these actions will provide habitat for both state-listed species and traditional game species such as American woodcock, ruffed grouse, and cottontail rabbits. This reclamation work will utilize canopy reductions, prescribed fire, and mowing.

Biomonitoring

A biomonitoring program was initiated in 1999 with the dual goals of 1) assessing the success of management activities at benefiting target species of greatest conservation need, and 2) guiding future management decisions. Surveys of breeding birds were conducted using standardized protocols in six survey years between 1999 and 2010 (1999, 2001, 2004, 2006, 2008, and 2010). The bird surveys detected 73 total species, including species of conservation need targeted by management (e.g. Common yellowthroat, Eastern Towhee, Ruffed Grouse, Prairie Warbler, Grasshopper Sparrow, Eastern Meadowlark, and Song Sparrow) (Table 1).

Shrubland bird species benefit from sites that are maintained in an early-seral stage, preferably <15 years post disturbance (Schlossberg and King, 2007). Abundance of various target bird species peak at different times following natural or management disturbance (Degraff and Yamasaki, 2003). For example, Indigo Buntings become abundant 1-5 years post disturbance or management and then decline as the vegetation grows and the tree canopy closes, whereas Common Yellowthroats become most abundant on a site 5-9 years after disturbance or management. Therefore, any rotation period for mowing/mulching cannot result in optimal productivity for the entire suite of early-successional species (Schlossberg and King, 2007, Degraff and Yamasaki, 2003). A rotation period (return timing) of 6-12 years allows DFW to maintain suitable (although not always optimal) habitat conditions for many of the target species at the site. The abundance of nocturnal species like Whip-poor-will and American Woodcock cannot be accurately assessed by the current biomonitoring data which, due to funding constraints, focused on diurnal songbirds.

The abandoned airstrip area of the Francis Crane Wildlife Management Area supports a variety of rare and declining grassland species that benefit from active management (both mowing and prescribed fire) such as grasshopper sparrow (*Ammodramus savannarum*), a state threatened species, and sandplain gerardia (*Agalinis acuta*), a federally-

endangered plant. In addition to ongoing Upland Program monitoring efforts, Natural Heritage and Endangered Species (NHESP) has conducted annual territory mapping surveys of grasshopper sparrows at Francis Crane. The Natural Heritage and Endangered Species Program is consulted regarding planned management practices to address conservation of rare species, and management activities are adapted accordingly.

Table 1. Francis Crane WMA Restoration Site Bird Checklist (detected during surveys from 1999-2010¹). Target species of conservation need are indicated in italics.

Species Present (+) or Absent (-) during bird survey year							
Target Species recorded during surveys	1999	2001	2004	2006	2008	2010	2012
<i>Alder Flycatcher</i> **	-	-	-	+	-	-	-
American Kestrel*	-	-	-	-	-	+	-
<i>American Goldfinch</i> **	+	+	+	+	+	+	+
American Woodcock*	-	-	+	-	+	-	-
<i>Black-billed Cuckoo</i> *	-	-	+	-	+	+	-
Brown Thrasher*	+	-	-	-	-	-	-
<i>Cedar Waxwing</i> **	+	+	+	+	+	+	+
<i>Common Yellowthroat</i> ***	+	+	+	+	+	+	+
<i>Eastern Kingbird</i> *	+	+	+	+	+	+	+
Eastern Meadowlark*	+	-	+	-	+	-	-
<i>Eastern Towhee</i> ***	+	+	+	+	+	+	+
<i>Field Sparrow</i> ***	+	+	+	+	+	+	+
<i>Grasshopper Sparrow</i> *	+	+	+	+	+	+	+
<i>Gray Catbird</i> **	+	-	+	+	+	+	+
<i>Great Crested Flycatcher</i> *	-	-	+	+	-	-	+
<i>Indigo Bunting</i> ***	-	-	+	+	+	+	+
<i>Northern Cardinal</i> **	+	+	+	+	+	+	+
<i>Northern Mockingbird</i> **	+	+	+	+	+	+	+
<i>Prairie Warbler</i> ***	+	-	+	+	+	+	+
Ruffed Grouse*	-	+	-	-	-	-	-
<i>Song Sparrow</i> ***	+	+	+	+	+	+	+
<i>Tree Swallow</i> *	+	-	+	+	+	+	+
<i>Willow Flycatcher</i> ***	-	-	-	-	-	+	-
<i>Yellow Warbler</i> **	+	-	-	+	-	-	-
Additional non-target species recorded during surveys							
American Crow	+	+	+	+	+	+	+
American Redstart	-	-	-	-	-	-	+
American Robin	+	+	+	+	+	+	+
Baltimore Oriole	+	+	+	+	+	+	+
Barn Swallow	+	-	+	-	+	+	+
Black-and-White Warbler	+	-	-	-	-	-	-
Black-capped Chickadee	+	+	+	+	+	-	+
Blue Grosbeak	-	-	-	-	-	+	-
+Blue Jay	+	-	+	+	+	-	+
Brown-headed Cowbird	+	+	+	+	+	+	+
-Chimney Swift	+	-	-	-	-	-	+
Chipping Sparrow	+	+	+	+	+	+	+
Clay-colored Sparrow	-	-	-	-	-	+	-
Common grackle	+	-	+	+	-	+	-
Common Loon	+	-	-	-	-	-	-
Double-crested Cormorant	+	-	-	-	-	-	+
Downy Woodpecker	+	-	+	-	+	+	-
Eastern Bluebird	-	+	+	+	+	+	+
Eastern Phoebe	+	+	+	-	+	-	+
Eastern Tufted Titmouse	+	-	+	-	+	+	-
Eastern wood pewee	+	-	+	-	-	-	+
European starlings	-	-	-	-	-	+	-
Horned Lark	-	-	-	-	+	-	-
House Finch	+	-	+	+	-	+	-
House Sparrow	-	-	-	+	-	-	-
House Wren	-	-	+	+	+	+	-
Killdeer	-	+	-	-	-	-	-
Mourning Dove	+	+	+	+	+	+	+
Northern Bobwhite	+	-	+	-	+	+	+
Northern Flicker	+	+	+	+	+	+	+
Orchard Oriole	+	-	+	+	+	+	+
Osprey	-	+	-	-	-	-	+

Ovenbird	-	-	-	-	-	-	+
Pine Warbler	-	-	+	+	+	+	-
Red tailed Hawk	+	+	+	+	+	+	+
Red-winged Blackbird	+	+	+	-	+	+	+
Ring-Necked Pheasant	+	-	-	-	-	-	-
Ruby-throated Hummingbird	-	-	-	-	-	+	-
Savannah Sparrow	-	-	-	+	+	+	+
Scarlet Tanager	-	-	-	-	-	-	+
Tufted Titmouse	-	-	-	+	-	-	+
Warbling Vireo	-	-	-	-	-	+	-
White-breasted Nuthatch	-	-	-	-	+	+	-
Wild Turkey	-	-	-	-	+	-	-

¹ Survey efforts varied between sample years in terms of number of plots and number of plot visits due to funding limitations

* Species present in Massachusetts Comprehensive Wildlife Conservation Strategy, ** Species present in Schlossberg and King 2007, *** Species present in both lists.

The following is a summary excerpt from NHESP restoration ecologist Chris Buelow's publication in July 2005: Grasshopper Sparrow land use and population trends at Francis Crane WMA. The Grasshopper sparrow (*Ammodramus savannarum*), which is a state listed threatened species, has shown a favorable response to the management by increasing its breeding territories (Table 2, Fig. 6). In 1989 there was only one territory mapped for grasshopper sparrows at the grassland area at Francis Crane WMA. But since management has begun (prescribed fire, mowing, tree removal, and invasive plant control) territories have peaked at 9 in 2004-2006 and remained steady at 6-7 from 2007-2010 (Table 2). As fire activity and habitat management continued to expand in the grassland, the Grasshopper Sparrows appeared to follow. The territories found cover the entirety of actively burned and restored grassland, as well as territories in the mown areas west and south of the model airplane runway.

In addition to Grasshopper Sparrow, other grassland indicators have been monitored since 2001. Breeding evidence of the state Endangered Upland Sandpiper has occurred twice in the sandplain grassland since 2000. The first observation, and the first ever documentation of the species breeding at the site, occurred in 2001 when an adult was observed tending to at least one chick in the northern area of the grassland. The second observation was of an Upland Sandpiper egg found depredated in the xeric portion of the western grassland. 2005 also saw a first breeding season record of the state Threatened Vesper Sparrow reported to NHESP. This record is awaiting documentation, but the species'

Table 2: Annual maximum counts of Grasshopper Sparrow

Year	Grasshopper Sparrows
1984	9 territories
1985	No data
1986	Not data
1987	3 territories*
1988	4 individuals
1989	1 territory*
1990	6 individuals
1993	2 territories
1994	2 territories
1995	3 individuals*
1996	1 individual*
1997	3 individuals*
1998	6 individuals*
1999	4 individuals*
2000	1 individual*
2001	4 territories
2002	3 territories
2003	6 territories
2004	9 territories
2005	9 territories
2006	9 territories
2007	7 territories

2008	7 territories
2009	6 territories
2010	6 territories

*denotes non-NHESP data (Bird Observer). Singing male constitutes territory presence is not unexpected due to the area's habitat characteristics and recent restoration work. Other breeding grassland birds in the sandplain grassland include a stable population of Savannah Sparrow and a small and fluctuating population of Eastern Meadowlark. Management within the sandplain grassland has also been correlated to the vigor and expansion of the Federally Endangered Sandplain Gerardia (*Agalinis acuta*), the recent re-emergence of the state Watch-listed Butterflyweed (*Asclepias tuberosa*), and the first documentation of the state-listed Chain Dot Geometer (*Cingilia catenaria*).

Rare Species & Wetlands Considerations

Priority Habitat for rare species occurs within the treatment area and 19 state-listed species (4 as Endangered, 5 as Threatened, and 10 as Special Concern) are documented on this site by the DFW Natural Heritage and Endangered Species Program (Natural Heritage). This includes vascular plants, birds, butterflies, moths, beetles, and reptiles. Natural Heritage provided seasonal operating restrictions that were followed by the Upland Program to conserve listed species

Invasive Exotic Species Control

Invasive plant control treatments occurred from 1999-2009 and were conducted by licensed pesticide applicators (Fig. 2) in cleared areas, as well as invasive exotic plants in adjacent areas (applicators are licensed under the Pesticide Control Act administered by the Massachusetts Department of Agricultural Resources (DAR).

All herbicides used are approved for use in sensitive areas. "Sensitive area" herbicides are approved through an additional detailed review of toxicity and environmental impacts beyond the typical two-tiered process of federal review by the Environmental Protection Agency and standard state review by the Massachusetts Pesticide Bureau (http://www.mass.gov/agr/pesticides/rightofway/Sensitive_Area_Materials.htm).

Historical/Cultural Resources

DFW consults with the Massachusetts Historical Commission (MHC) regarding potential for pre-historic Native American sites on all managed properties, and for the Frances Crane WMA, MHC has determined that there is no likely impact on pre-historic artifacts at this site. DFW applies Best Management Practices (BMPs) to conserve both potential historic (e.g. Native American encampment areas) and visible cultural resources (e.g., stone piles, stone walls and cellar holes) at all sites by mapping cultural resources with GPS, by using existing roads whenever possible, by establishing landing areas on previously utilized roadside sites, and by preventing heavy machinery from crossing stone walls and foundations, and by restricting machinery to operating under dry or frozen conditions to minimize disruption of any historical artifacts that may lie beneath the soil surface.

Environmental Permitting

Management activities on DFW and other state-owned land in Massachusetts are subject to a variety of Federal and Massachusetts laws and regulations. Many of these regulations focus on preventing damage to water and wetland resources, while others protect endangered species and cultural resources, or prevent accidental fire damage. The full text of Massachusetts General Laws is available at www.state.ma.us/legis/legis.htm.

DFW habitat restoration projects comply with permit requirements of the Massachusetts General Law (MGL) Chapter 132, The Forest Cutting Practices Act (when applicable), and specific components of MGL Chapter 131, The Wetlands Protection Act which requires Forest Cutting Plan or Site Plan review by the Massachusetts Natural Heritage & Endangered Species Section staff for any management activities that coincide with estimated or priority habitat for rare species. DFW management activities that do not fall within estimated or priority habitats are still reviewed by Natural Heritage for potential element occurrences (EO's) of rare species that are not reflected in the estimated or priority datalayers. Mitigation procedures, if necessary, recommended by Natural Heritage to conserve rare species are implemented.

Fig. 3. Frances Crane North Management Units

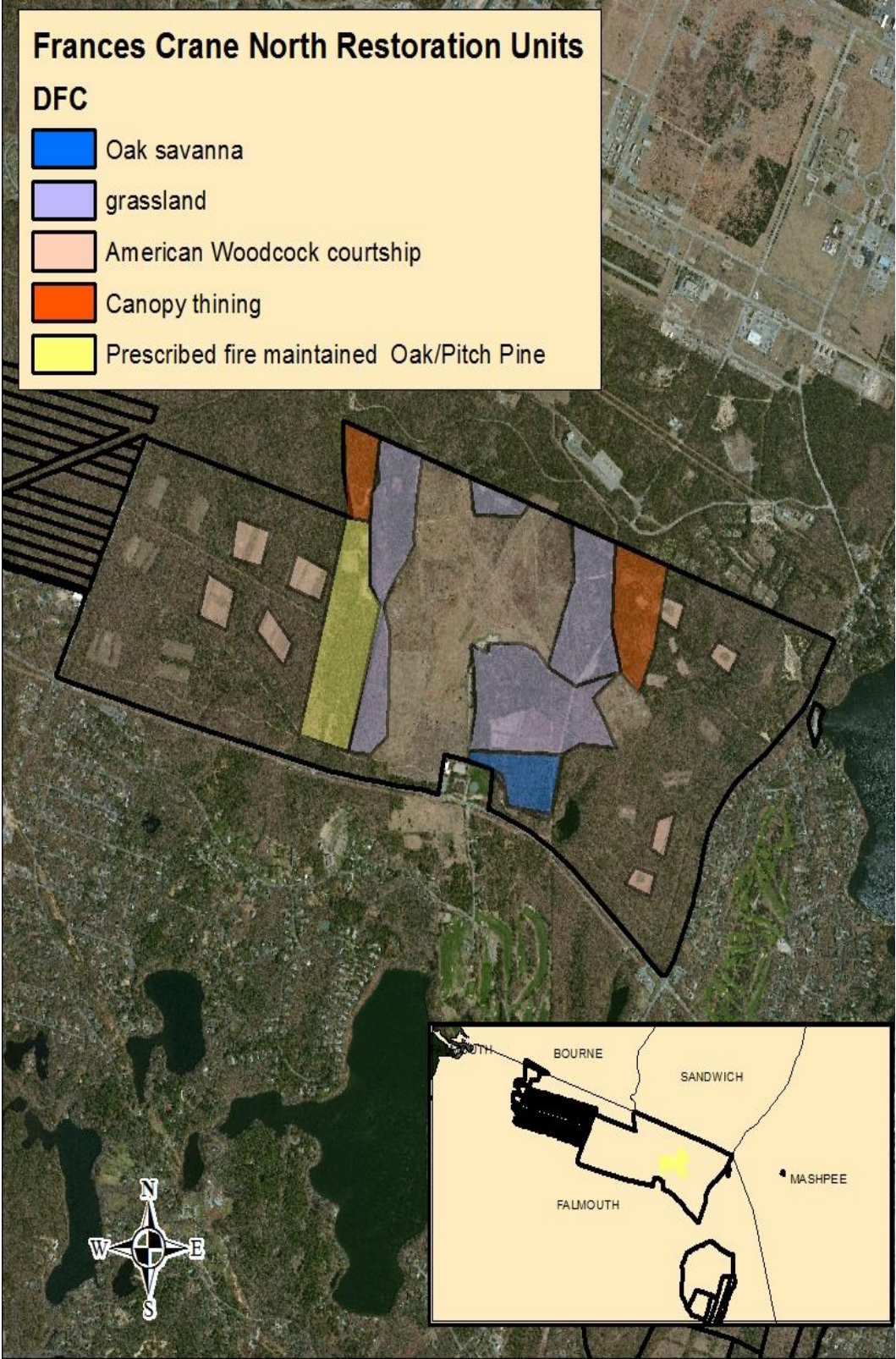


Fig. 3A. Frances Crane North Grassland Management Units

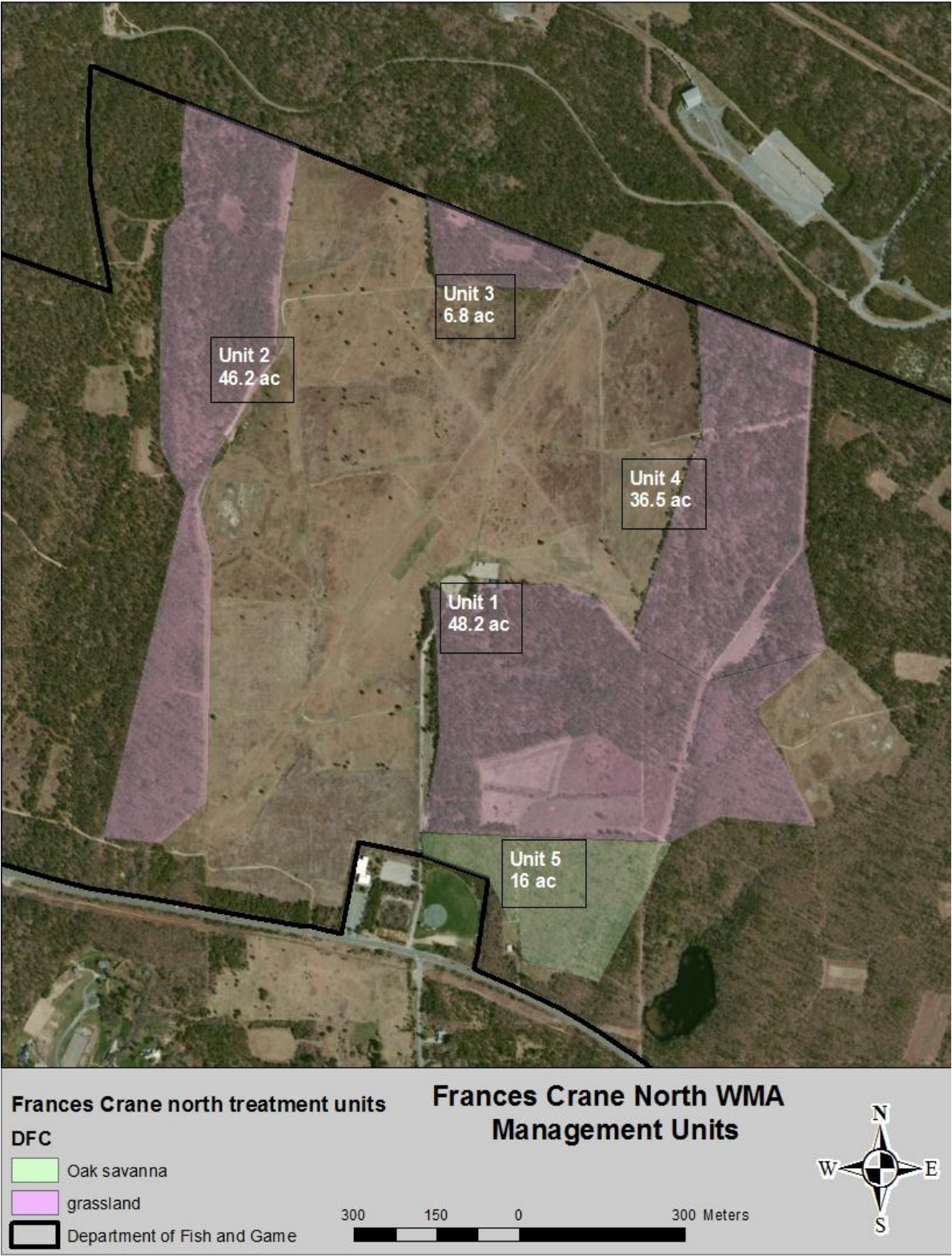


Figure 4. Pre and Post Mowing Photographs, A-G



MassWildlife Photo by Jill Liske-Clark

A. Pre-treatment photograph showing a hedgerow cutting through old field areas. Invasive plants can be seen in the foreground.



MassWildlife Photo by Ben MazzeB. A retention area of pitch pine scrub oak which remained within the treated savannah habitat at the southern portion of Francis Crane WMA.



MassWildlife Photo by Ben Mazzei

C. Hedgerows consisting of Norway spruce, black locust, red cedar, and pine spp. Hedgerows were removed in the grasslands to create a continuous site line which would benefit area sensitive grassland species (Upland sandpiper, grasshopper sparrow, vesper sparrow)



MassWildlife Photo by Ben Mazzei

D. Reclaimed fields after having hedgerows removed to expand site line of the grasslands.



MassWildlife Photo by Ben Mazzei

E. Reclaimed field areas after two growing seasons. Notice the re-sprouting invasive black locust sapling in the picture which will have to be controlled.



MassWildlife Photo by Jill Liske-Clark

F. Notice the resprouting woody invasive exotic plants in the foreground. Invasive plants continue to be a reoccurring issue. Follow up applications to treat invasive exotic plants must be considered when planning management activities.

Figure 5. Reclamation Machinery Photographs, A-C).



MassWildlife Photo by Ben Mazzei

A. Feller buncher removing hedgerows within the grasslands at the Francis Crane. Some grassland bird species require large patches (>25 acres) without hedgerows blocking the sightline.



MassWildlife Photo by Ben Mazzei

B. Low value hedgerow trees being turned into chip material. The hedgerows were selectively removed in order to increase the sightline and improve the quality of the grassland at Francis Crane WMA.



MassWildlife Photo by Ben Mazzei

C. Low quality tree material being turned into chip material in order to create a pitch pine scrub oak savannah to benefit species of conservation need at Francis Crane WMA.

Figure 6, A-E. Francis Crane WMA, grassland area, 1950-2008. Photograph A shows the Coonamesset Airport and Jensen Farm in 1950 which would later become Francis Crane WMA. Photographs B-E show the reclamation work and grassland expansion through habitat management (fire, mowing, and tree removal) to benefit grassland species of conservation need which require large patches of open habitat



A. Coonamesset Airport and Jensen Farm in 1950 which would later become the grassland area of the Francis Crane WMA.



B. Francis Crane WMA, grassland area, 1994



C. Francis Crane WMA, grassland area, 2001. Notice grassland expansion in the northeast and southern portions WMA



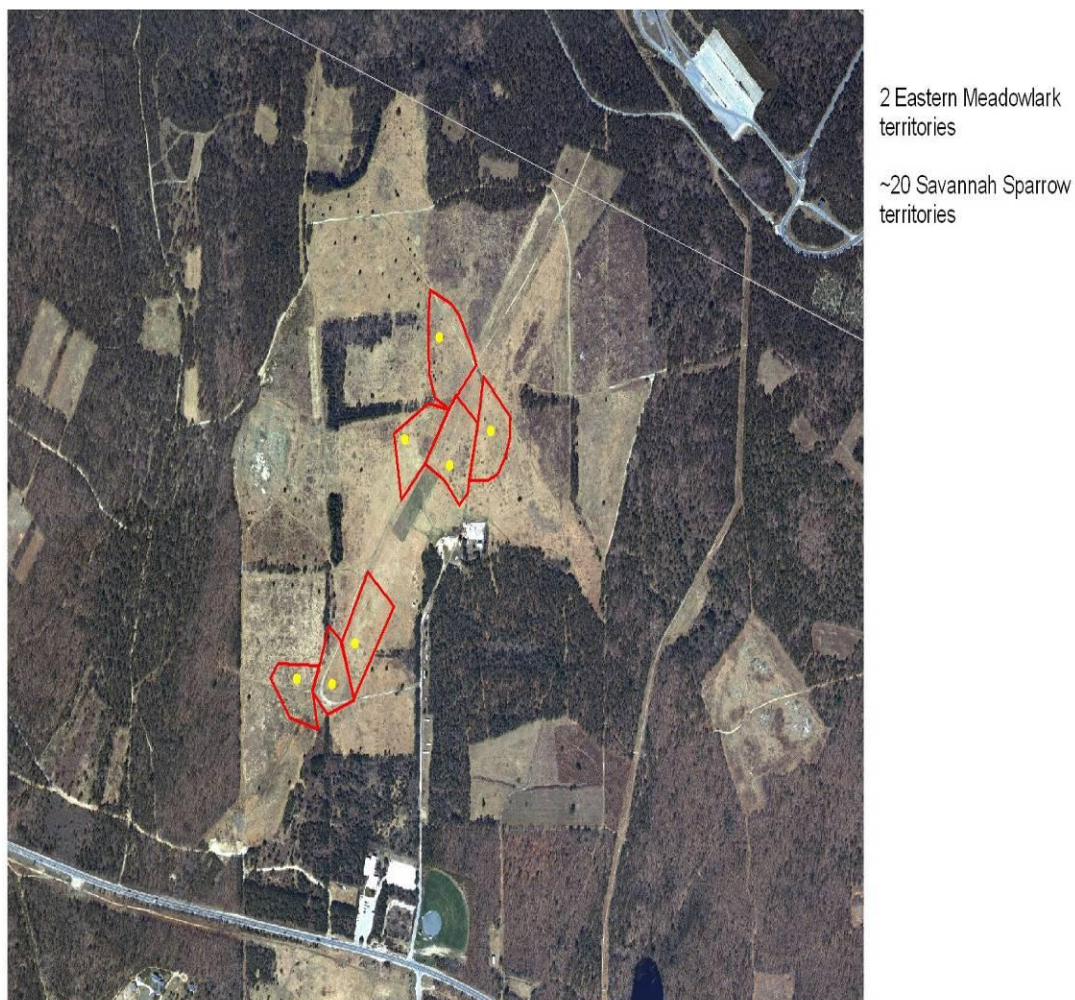
D. Francis Crane WMA, grassland area, 2005. Notice grassland expansion in the western portions of the WMA



E. Francis Crane WMA, grassland area, 2008. Notice grassland expansion in the southern area and hedgerow removal throughout portions of the WMA

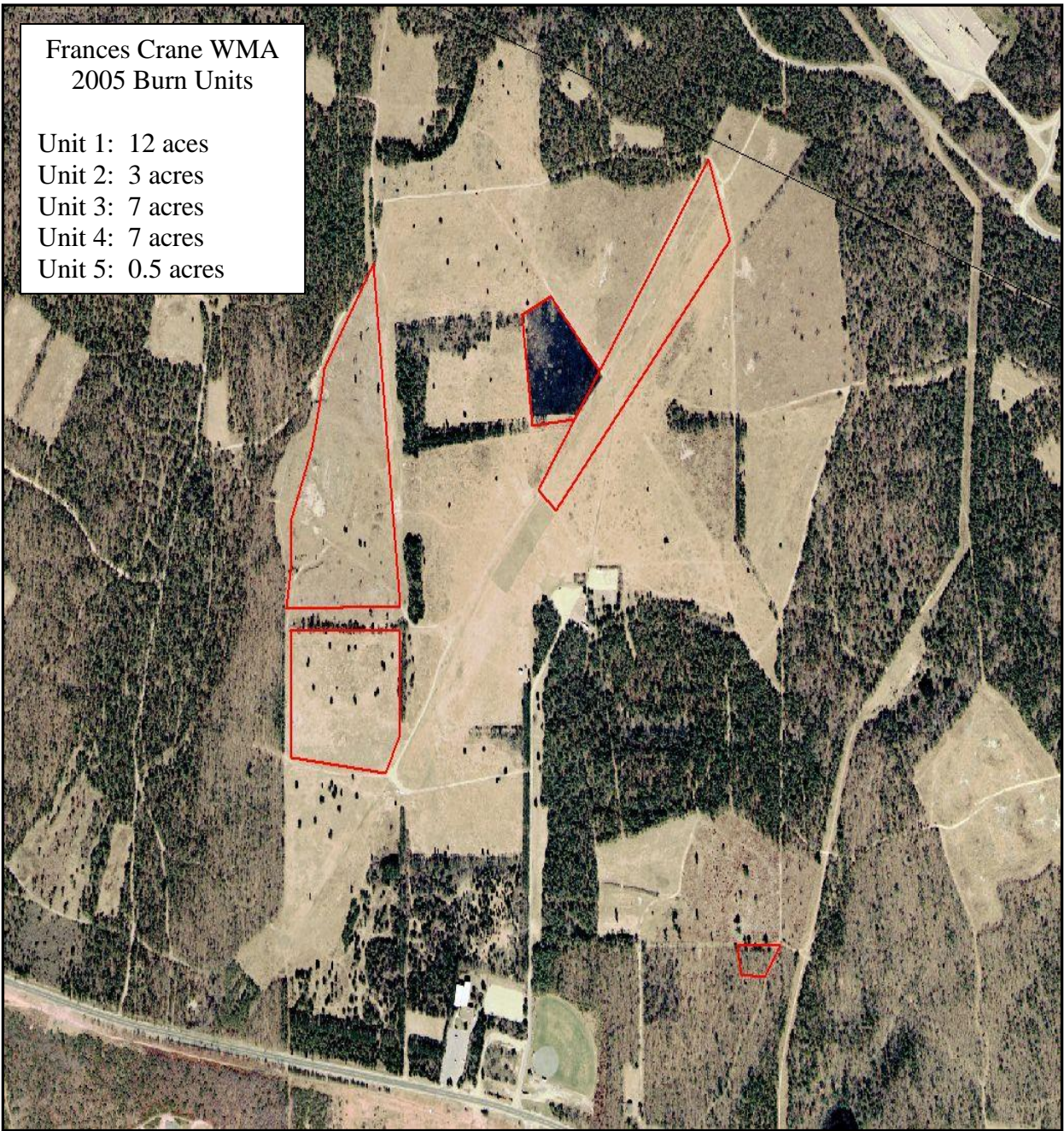
Figure 7. Mapping of Grasshopper Sparrow, Eastern Meadowlark, and Savannah Sparrow territories at Francis Crane WMA in 2008

Grasshopper Sparrow Territories 03 June 2008



Territories and map created by Chris Buelow, NHESP

Figure 8. Mapping of 2005 burn units at Francis Crane WMA



MassWildlife map by Chris Buelow

Figure 9, photographs A-B. Francis Crane grassland burn units post prescribed fire



MassWildlife Photo by Chris Buelow

A. Burn unit after one growing season at Francis Crane. The grasslands are managed with prescribed fire in order to stimulate native fire evolved species of conservation need.



MassWildlife Photo by Chris Buelow

B. Burn unit after one growing season at Francis Crane. The grasslands are managed with prescribed fire in order to stimulate native fire evolved species of conservation need.

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